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Multiliteracies Pedagogy Promoting Young Children's Ecological Literacy on Climate Change

Chin-Chin Wong and Kristiina Kumpulainen

Abstract

This chapter discusses how to nurture young children's ecological literacy (eco-literacy) on climate change encompassing seven core skills; empathy, collaboration, communication, creativity, systems thinking, critical thinking and problem-solving. The chapter draws on the *Riddle of the Spirit* project designed to support children's eco-literacy in making connections between themselves and climate issues through playful and multimodal activities embedded in a cross-cutting narrative on Finnish myths around forest. The chapter makes visible how young children's engagement with and learning of eco-literacy, including sustainability-oriented knowledge, skills and empathy of the natural world can be supported through novel designs informed by Multiliteracies pedagogy.

Keywords: sustainability education, ecological literacy, Multiliteracies pedagogy, multimodality

Introduction

Sustainability and socio-environmental issues, such as climate change, urbanization and biodiversity loss, are increasingly recognised as important global topics to be addressed by 21st-century education (Hedefalk, Almqvist & Östman, 2015). Recent movements to promote children's environmental awareness and understanding include green schools, outdoor schools, forest kindergartens and schools, nature-based education and the farm-to-school movement (Assadourian & Mastny, 2017). In Finland, the national core curricula (there are three: an Early Childhood Education and Care curriculum (0-5 year olds); a pre-primary curriculum (6 year olds); and the basic education curriculum (7-16 year olds), highlight the necessity of a sustainable way of living as one of the underlying values of education (FNBE, 2016, 2017). The curriculum mandate that formal education should develop children's eco-social knowledge and ability, understanding of human dependence on ecosystems, and nurture children's knowledge, skills and appreciation of their environment for a sustainable future. As a result, teachers are required to include exploring and making sense of the natural environment in their teaching, and to promote children's outdoor learning opportunities.

Finnish education has traditionally underscored the importance of cultivating human relationship with nature. Forest covers more than 70% of Finland's land area and it is regarded as a valued national resource encompassing multi-faceted personal, social, cultural and economic meanings and values (Finnish Heritage Agency, 2017). For many people in Finland, forest is a place with significant importance for the development of their identities. The forest accounts for a communally shared mental landscape, a privately experienced personal place and a recreational and working-life environment. Summer cabins, scouting, roaming, hunting, and mushroom and berry picking, as well as more recent geocaching, airsoft and trail running characterise the many activities related to the forest in Finland. The right of public access to the wilderness or the "right to roam" have ensured all people in Finland to enjoy and experience the forest regardless of ownership. Families in Finland have played a large role in passing on the traditions of roaming in the forest, and in keeping these traditions alive, together with formal education. Although people's relationship with forest is strong and varied in Finland, it faces many threats in changing times. Globalisation, urbanisation and new recreational alternatives have made people

become more distant from nature. Hence, in Finland, it is seen as important that attention is paid to maintaining and enhancing children's multi-faceted opportunities to build a relationship with, and appreciation of, their natural environments, the forest included. The Finnish government has also set sustainable development as a core goal of its 2030 agenda which includes solving climate change as a prioritized action (Lyytimäki & Lähteenoja, 2016). Educating the next generation to understand, appreciate and take responsibility over the natural environment and climate is hence seen as an important national ambition to be cultivated by formal educational institutions already early on.

Although there are some positive findings from Europe, UK and Australia showing how learning beyond the classroom can promote children's interest, values and caring for their local places and the natural environment (e.g. Cumming & Nash, 2015; Harris, 2017), it is acknowledged that creating pedagogical activities for formal education that can support children's socio-environmental awareness and systems thinking, that is, understanding the interconnectedness of human and natural systems, is a complex and demanding endeavour, and there is an ongoing need for research and the development of pedagogical models, materials and practices (Renshaw & Tooth, 2017). These challenges also apply to Finland, despite a context where an education system places great trust in teachers' professionalism and creativity for designing children relevant learning opportunities in and outside the classroom, and where there is no pressures from high stakes standardised testing (Kumpulainen, 2018). In this chapter, we will consider how a Multiliteracies pedagogy can be harnessed to support children's interaction with, caring of, and learning about their natural environment and its climate.

Ecological Literacy and Multiliteracies Pedagogy

Our work draws on the concept of ecological literacy (eco-literacy), which refers to 'the ability to understand the basic principles of ecology—the processes by which the Earth's ecosystems sustain the web of life' (Stone, 2017, p. 36). The term eco-literacy began to be advocated broadly in the 1990s by systems theorist Fritjof Capra (1995) and environmental educator David Orr (1992). The two scholars also founded and served a non-profit organization, Centre for Eco-

literacy, which advocated for education on sustainable living. Capra (1995) and Orr (1992) argue that eco-literacy is essentially about for understanding the interconnectedness of human and natural systems, thereby, creating sustainable societies. Based on these scholars' work, we can derive seven interconnected skills that are vital for developing an understanding of eco-literacy (Wong, 2018). Namely, empathy, collaboration, communication, creativity, systems thinking, critical thinking and problem-solving skills (see *Figure 1*).

Empathy addresses the importance of developing an affective and, hence, a personal and caring relationship with the natural world. Collaboration underscores the importance of being able to work and interact with others for creating sustainable futures. Communication, which is closely linked with collaboration, underlines the ability to express ideas and knowledge through multiple forms. It also entails developing a shared language and meaning making system for knowledge sharing and creation. Creativity is to do with being able to generate fresh and novel ideas to solve environmental or sustainability-related challenges, and to find new ways of living in ways that do not harm the environment. Systems thinking refers to the ability to understand the world as a sum of interconnected systems. Critical thinking calls for analytic meaning-making that includes recognising various agendas and interests in people's behaviour and interaction over the natural world. It is also to do with rational analysis of environmental phenomena in order to make informed decisions. Problem-solving skills stress the ability to define problems, evaluate alternatives and implement solutions for achieving a way of sustainable living.

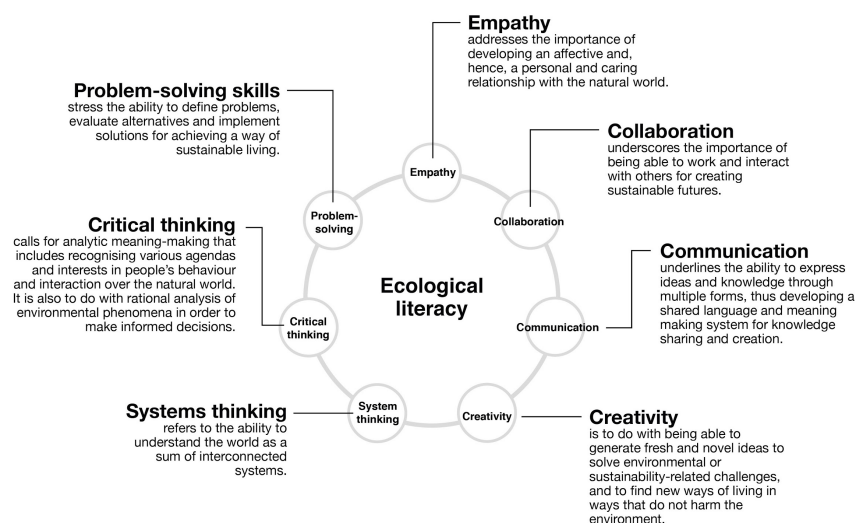


Figure 1. Seven skills as the core of eco-literacy

In this chapter, we argue that the core skills of eco-literacy call for holistic, participatory and analytic learning opportunities realised via experiential, place-based and interdisciplinary approaches (Orr, 1990). We propose that the pedagogy of Multiliteracies originally outlined by the New London Group (1996) offers a potential educational framework to design and support young children's eco-literacy. A pedagogy of Multiliteracies underscores the importance of multiple modalities in representation and meaning-making with a specific attention to four core components, namely: 1) *Situated Practice* that is based on the importance of drawing on the experience of meaning-making in life-worlds; 2) *Overt Instruction* that asks for the development of an explicit metalanguage for discussing elements relevant to design; 3) *Critical Framing* that calls for critical interpretation of the social contexts, power relations and purposes of designs of meaning; and 4) *Transformed Practice* in which students, as meaning-makers, turn into designers of their social futures (New London Group, 1996; Serafini & Gee, 2017).

Altogether, the components of Multiliteracies pedagogy are in line with eco-literacy that stresses going beyond the basics skills of reading, counting and computing towards cultivating human capacity to observe nature and to relate to knowledge with insight and quality of thought, including seeking out connections, making inferences and informed decisions (Orr, 1992). Hence, we hold that a Multiliteracies pedagogy combined with the notions of eco-literacy creates a powerful design to foreground children's empathy, systemic, critical and creative thinking over their natural environment. It offers a qualitatively novel, yet practically uncharted educational opportunity for the design and promotion of young children's engagement with and learning about sustainability-oriented knowledge, skills and empathy of the natural world.

In the next section, we illuminate our approach via a *Riddle of the Spirit* project implemented in a Finnish primary school, and analyse the nuanced ways in which the project and its novel designs addressed children's engagement with and potential learning of eco-literacy. In this connection, we want to point out this chapter is not about showing progressions in individual children's eco-literacy skills as the result of the project. That is not been our intention, and neither is the timespan of the project adequate for such investigation. Instead, we are interested in describing and conceptualising the project including its novel materials used in- and outside

the classroom and how these supported the children's engagement in eco-literacy learning endeavours. In line with the sociocultural theorising, we hold that learning has social and cultural origins, and hence what happens in joint activity shapes individual thinking and learning (Vygotsky, 1978). We end our chapter by considering the implications of our work for early years and primary education for enhancing eco-literacy in the lives of children.

The Riddle of the Spirit Project

The *Riddle of the Spirit* project introduced eco-literacy to seven to nine-year-olds through narrative and playful multimodal and multi-sensory activities and materials. The project and its unique materials were specially designed to enhance children's understanding of the interrelationship between themselves and climate issues through a story-line about nature spirits embedded in the ancient Finnish myths about nature. During their playful exploration and meaning-making processes supported by the developed *available designs* (Hassett & Wood, 2017; New London Group, 1996), the children were encouraged to explore, imagine, and make sense of different aspects of the natural world, and which afforded them with different learning opportunities for developing their eco-literacy skills; empathy, collaboration, communication, creativity, systems thinking, critical thinking and problem-solving on climate change. Overall, the project was novel to Finnish education, and to our knowledge also globally.

The project was led by Chin-Chin Wong and it resulted from a collaborative design research between the master's degree program in Creative Sustainability at Aalto University and the Joy of Learning Multiliteracies (MOI) program at the Playful Learning Centre of the University of Helsinki (Wong, 2018). The project drew on the original *Whisper of the Spirit* material created by Erfving, Hintsa, Sintonen, Sairanen, & Kumpulainen (2017) as part of the MOI-research and development activities (see also Sairanen et al. and Nordström et al. in this volume). Besides encouraging children's and their teachers' environmental exploration, the original *Whisper of the Spirit* material builds on ancient Finnish beliefs and myths about nature. The spirit characters in the material are drawn from Finnish mythology, including Ukko, the thunderstorm spirit, Tapio, the forest spirit, and Vetheinen, the water spirit. The present project and its collaborative design

research identified an opportunity to utilize these spirit characters as story characters to support children's exploration and meaning-making of eco-literacy on climate change.

Altogether, the *Riddle of the Spirit* project involved seven pedagogical activities with specially-designed templates and physical props, teacher facilitation and collective discussions that supported the children in exploring, imagining and making connections between themselves, the spirit characters and climate issues. The teachers acted as facilitators to orchestrate joint exploration and meaning-making, as well as learning partners to engage the children in experiential and imaginary activities about nature in and out of the classroom. Using a riddle of the 'thunderstorm spirit' losing its climate control as the starting point, or as the metalanguage and core inquiry of the project (i.e. *Overt Instruction*), the children had to investigate and identify the reasons for the phenomena drawing on their experiences in the world (i.e. *Situated Practice*), and to create imaginative solutions (i.e. *Transformed Practice*). The imaginative story setting and multiliteracies materials stimulated the children's analytic engagement with and learning of eco-literacy in multimodal and playful ways (i.e. *Critical Framing*). The designed activities and materials guided the children connecting their established ways of making sense of the world through cycles of individual and collective meaning making and transformation, thus inspiring the children to invent their own solutions to the problems around climate change, in accordance to the pedagogy of Multiliteracy.

The Riddle of the Spirit Project in Action

The project participants included 32 native Finnish-speaking first and second grade students aged seven to nine, their two teachers and one teaching assistant in a primary school in the city of Espoo, Finland. During the project, the teachers and students were split into two classrooms for small-group-oriented activities except the introduction and closing discussions. The entire project was implemented in two morning sessions, lasting a total of eight hours. After obtaining parental consent, the workshop data were mainly documented through classroom observations by Wong, including photos, videos and field notes.

The project began with the premise that ‘all things, both animate and inanimate, had their own spirit ...’ (Erfving et al., 2017, p. 4). It consisted of an introductory story-telling session and three workstations - Find, Think and Make - with a total of seven distinct learning activities (see Figure 2).

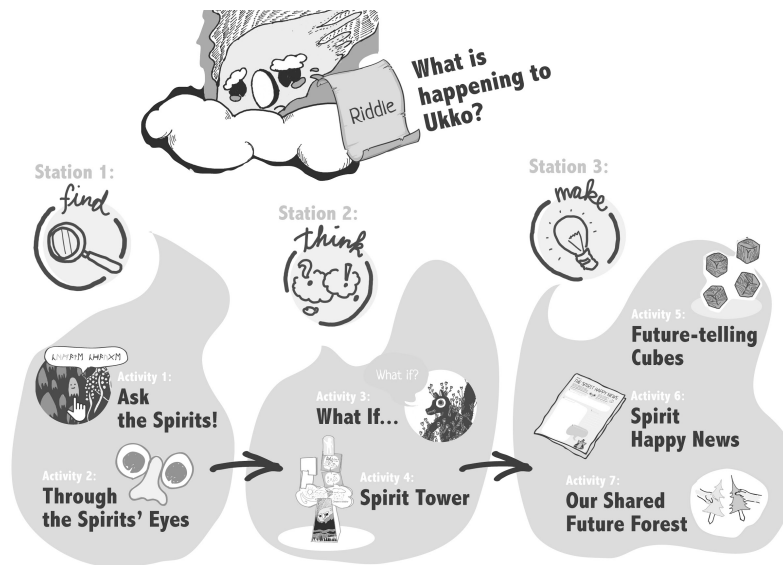


Figure 2. The structure of *Riddle of the Spirit* project

A riddle acted as a starting point and cross-cutting narrative throughout the realisation of the project. In short, Ukko, the thunderstorm spirit, lost his climate control, which influenced the villagers’ harvest. In this narrative setting, the goal for the children was to uncover the reasons for Ukko’s problem and create a solution to make him happy again. To achieve this goal, each workstation had a specific learning purpose: workstation 1 ‘*Find*’, asked the children to gather information about relevant concepts, such as carbon footprint and global warming, using literature and through their observations. In workstation 2, ‘*Think*’, the children focused on connecting their acquired information to their daily experiences and the riddle narrative. In workstation 3, ‘*Make*’, the children created an ending for the riddle, encompassing *Transformed Practice*. Each activity served as a piece of the puzzle that helped the children make sense of the bigger picture of climate change in accordance to the Multiliteracies pedagogy.

The teachers began the project by introducing the characters and the riddle narrative to participants with a relevant illustration. This visual was integrated into the collective storytelling session, which combined different playful activities to foster the children's imagination and immersion into the story's setting. For example, the children were invited to role-play the characters and the storyline and to 'call Ukko' by mimicking the sound of thunder.

Workstation 1: 'Find'

In the first activity, *Ask the Spirits*, the children were guided to gather information and ideas to solve the riddle by imaginatively communicating with other spirits. The spirits only spoke their own ancient language, so the children had to make sense of the phrases by converting the mysterious characters into Finnish language using a dictionary purposefully designed as part of the project's materials. Each small group of children received a piece of an illustration with the mysterious phrases as hints to investigate. For example, the illustration showed one spirit using the phrase, ' HIIJALANJÄLKI '. By using the dictionary tool, the children translated these unidentified characters into 'hiilijalanjälki', which is 'carbon footprint' in Finnish. Thus, the dictionary tool led the children to familiarise themselves with key conceptual language relevant to climate change. Here, the available designs, played a central role in supporting the children's meaning-making of eco-literacy with attention to children's information seeking, problem solving and learning about relevant concepts in making connections between different symbols for communication and meaning-making.

After translating the characters into Finnish, each sub-group explored one of four phrases about climate change: 'weather and climate', 'global warming', 'carbon footprint' or 'greenhouse gases'. To understand the phrases, the groups were given relevant books by the teachers to search for their meanings. The teachers closely guided the children to help them make sense of the abstract concepts (see *Figure 3*).



Figure 3. The teacher reads with the students about global warming from a relevant book

Lastly, each group shared their learning and explained the concepts to the other children and teachers. This collaborative and communicative sharing session was followed by a teacher-facilitated discussion during which the children were encouraged to make connections across the concepts and transform the sensed meanings into their own understanding.

The second activity, *Through the Spirit's Eyes*, was designed to encourage the children to explore the outdoor natural environment and problem-solve the riddle through observation and multimodal, multi-sensory and critical meaning-making. The activity was framed by a narrative about the ancient Finnish wizard, Myrrysmies, who had three magical tools that could help the children to empathise with the spirits: Tapio's mask, Vetehinen's magnifying glass and Ukko's binoculars. These specifically designed tools acted as role-playing props for the children's exploration and learning of eco-literacy.

During the activity, the children and their teachers relocated to the school's backyard, which included a man-made playground area and natural rocks, hills and trees. Each prop had a short narrative description about its corresponding spirit. For example, the description about Ukko's binoculars was: 'Ukko provides fresh air and clean rain water to all lives on earth. He doesn't like anything that makes the air and rainwater dirty'. The descriptions enriched the children's imagination and guided them to consider elements that affected the spirits' emotion. Next, the children took turns using the three role-playing props and freely explored the backyard environment. This role-play activity with the props encouraged the children to dwell into

different areas in the backyard and to observe and make-sense of the surrounding features (see *Figure 4*). The props as available designs acted as lenses and inspired children to observe and empathise with the environment as well as making connections between their observations and the ideas brought forward by the riddle and their own earlier experiences.

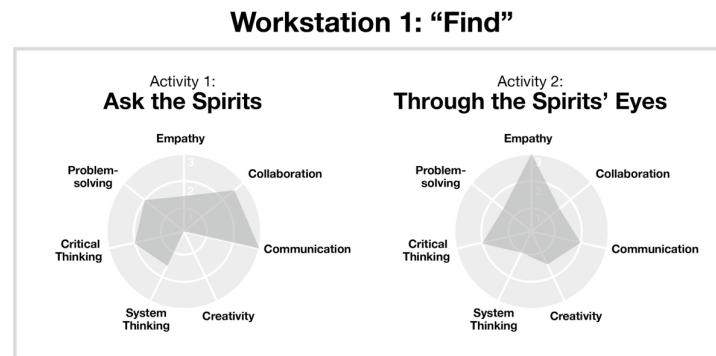


Figure 4. Children examine a piece of rock with the Tapio's masks.

After their outdoor exploration, the children returned to the classroom and discussed their observations and experiences. They shared ideas on what might cause Ukko to lose his climate control. Some children suggested that the problem was due to people's disbelief in Ukko or Ukko's loneliness in the sky. Some children raised the topic of cars and their exhaust gases and wondered if air pollution could be the reason. With the teachers' guidance, the children discussed the connection between vehicle exhaust gases and the concepts of greenhouse gases and global warming, which created opportunities for engaging in critical and systems thinking. Moreover, here, the collective discussion led children to create new meanings building on their previously experience and findings. Through these imaginative joint activities, the children were guided to consider global warming as a reason for Ukko's problem.

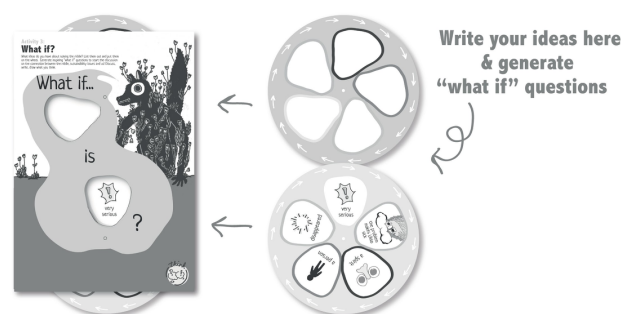
In sum, workstation 1 'Find' introduced the basic concepts of climate change to the children via guided and, yet, playful literature research. The plot of the riddle also supported the children's self-directed spatial exploration in the outdoor environment whilst making sense of abstract knowledge. The children's own experiences and understanding were also actively harnessed for

making meaning of the phenomena around climate change. In terms of the seven core skills of eco-literacy, this workstation cultivated the children's empathy towards the natural environment by experiential exploration, collaboration and communication during collective meaning-making. It also oriented the children's mindsets for critical thinking (see *Figure 5*).



Workstation 2: 'Think'

In workstation 2, 'Think', the aim of the activity *What If* was to inspire the children's thinking and creativity by generating open-ended questions using a tool, the question generator, developed for the project. The tool (see *Figure 6*) consisted of a simple card frame with two rotatable wheels attached underneath. One wheel contained empty slots for writing the children's ideas on solving the riddle and the other contained pre-set phrases with coordinated illustrations. By manipulating the two wheels, the tool would formulate open-ended questions with the children's ideas using the structure 'What if ... is ...?'.



The teacher posted five ideas from the children’s collective findings to the empty ‘what if’ wheel and raised questions, such as ‘What if ‘loneliness’ is ‘a spirit’?’, ‘What if ‘vehicle exhaust gas’ is ‘the problem [that] makes Ukko sick’?’. In this activity, the tool, as available design, extended the discussion and the children’s thinking on the climate issues and story by building questions on the children’s previous findings. During discussion, the role of teacher was important in guiding the children to identify cause-effect relationships and to connect their earlier observations and findings to their problem solving of the riddle.

The fourth activity *Spirit Tower* aimed to illustrate human dependence on natural resources by visualising the linkage between daily activities and the spirits. It combined visual mapping and the playfulness of building blocks to portray this abstract connection. Three towers were developed for this in total; Ukko’s tower, Tapio’s tower and Veteinen’s tower. Each tower-like prop and a stack of cards (see *Figure 7*) were used by a small group of children as part of their joint activity. Each card presented an element of natural resources or human activity, such as a raindrop, fishes, a wooden log, a meal, books and a sauna activity. Blank cards were also provided so the children could add more elements to the towers according to their own understanding and imagination.

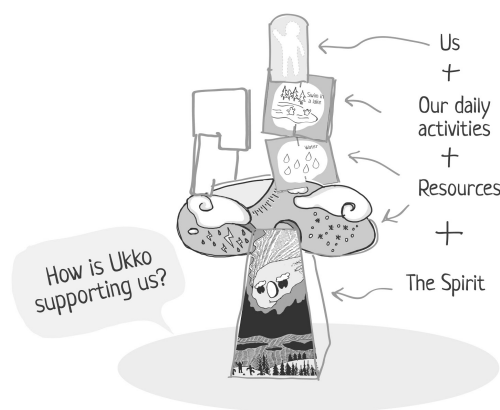


Figure 7. Instructions and details about the towers and cards

Starting with the question ‘how are the spirits supporting us?’, the goal of this game-like activity was to seek connections between the cards, match them together and build the spirit towers with those pairs. For example, the connected cards of a wooden log and a wooden cottage to the Tapio’s tower showed that wooden cottages were made of wood, which was a resource from the forest. This activity attempted to inspire the children to think beyond observation and add further meanings, concerning resources consumption, to daily objects and the children’s previous experiences.

In sum, the two activities of this workstation were designed to stimulate the children’s critical and systems thinking, in order to develop their understanding and knowledge about the relationship of their own daily interaction and the natural world. The collaborative activities and communication that these activities demanded also contributed to the children’s engagement with and learning about eco-literacy (see *Figure 8*).

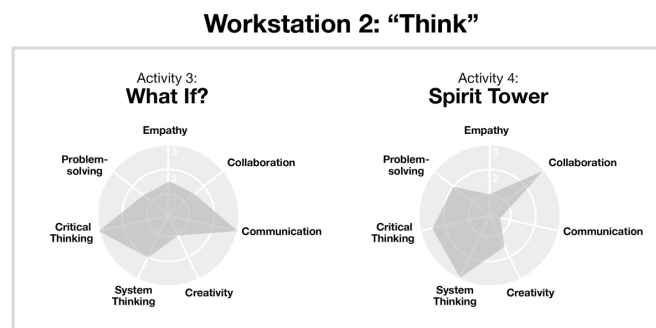


Figure 8. The core skills of eco-literacy addressed in in workstation 2: ‘Think’

Workstation 3: ‘Make’

Workstation 3, ‘Make’ focused on creating a story ending for solving the riddle based on the ideas developed from the previous activities. Besides problem solving, the activity aimed to inspire the children’s imagination and empathy in interacting with the spirit characters. The designed props for the fifth activity, *Future-telling Cubes*, were story cubes with phrases or illustrations on each side. These were designed to inspire the children to create stories with a random combination of elements. The activity started with a narrative which the ancient wizard, Myrrismies, had four magical cubes that could help the children foresee the future of humans

and spirits. Each cube represented one story element: the spirits, humans and other characters, emotions and scene setting. Blank cubes were also provided to the children to create their own elements.

The other activity *Spirit Happy News* utilized a newspaper-like story map template as a structure to lead the children to create a happy ending for Ukko and solve the riddle. The newspaper was a metaphor used to emphasize the value of sharing these stories with others. During the activity, each sub-group rolled the future-telling cubes to formulate the key elements for their story creation and collaboratively create the ending with a given set of spirit happy news template.

The last activity *Our Shared Future Forest* gathered the children's wishes and aspirations about the well-being of themselves and the forest. The aim of the activity was to encourage the children to rethink their own relationships with nature and imagine preferable futures. Each sub-group of children was given a tree-shaped template to record their wishes; together, the trees formed an illustration of a large forest. Some of the children's wishes, translated to English, were: 'the forest will not be destroyed', 'plants grow bigger' and 'we want peaceful places with animals'. These wishes reflected that the children were becoming aware of socio-environmental issues and hoped for alternative circumstances.

In sum, workstation 3 'Make' was designed to inspire the children to imagine and create positive environmental futures by drawing on their learnings from previous activities and to express their ideas via diverse forms of communication, such as dialogues, text and drawings. This workstation emphasized nurturing the children's creativity, problem-solving skills and communication skills (see *Figure 9*).



Figure 9. The core skills of eco-literacy addressed in in workstation 3: 'Make'

At the end of the project, the children and teachers jointly discussed their learning experiences, as described below:

Teacher: 'How is Ukko related to us?'

Students: 'Ukko has a new status nowadays, different from before ...'

'Climate change is because of us ...'

'We can make Ukko happy again!'

Teacher: 'How can we help Ukko to be strong and healthy again?'

Students: 'We need to stop pollution.'

'Recycle ...'

'Shop reasonably.'

These interactions reflect the children's awareness in the connections between themselves, their daily activities and climate issues, acquired from the designed learning activities. In their interactions with the teachers, the children showed awareness that climate change, which was caused by 'us', was the reason for Ukko's problem. The children proposed that changing their own daily practices, such as stopping pollution, recycling and shopping reasonably, could help Ukko become healthy again.

Conceptualising and Learning from the *Riddle of the Spirit* Project

There are distinct pedagogical designs that our work brings forth to guide education efforts in relation to promoting children's engagement with and learning about eco-literacy. Namely, framed by the core notions of eco-literacy and Multiliteracies pedagogy our work speaks to the importance of 1) storying, 2) phenomenon-based learning 3) material affordances for multimodal engagement, and 4) play and imagination as core design principles for the teaching and learning of eco-literacy.

Storying

The *Riddle of the Spirit* was based upon a cross-cutting storyline on old Finnish myths on the forest that created an imaginative context for children to explore a real-world phenomenon (see also Egan, 2005). The core activity was built on the children's imagination and meaning making of the spirit characters, the riddle and climate issues. In following Vygotsky (2004), the designed materials and activities of the project mediated the children's imagination, which then also mediated their experiences of reality. Furthermore, the structured storyline's mysterious problem-based setting connected the children emotionally to the characters and their living environment. Its goal was to enhance the children's empathy towards the spirits' problems, namely, climate issues. Also Vygotsky (2004) points out that the complex relationship between imagination and reality includes an emotional element. Emotions mediate how we experience ourselves, others and the world around us.

Altogether, our learnings from the *Riddle of the Spirit* project point out the importance of storying in cultivating and enhancing children's eco-literacy. Storying foregrounds eco-literacy as a site of overlapping narratives that convey past and present, science and imagination, whether they are about people, plants or animals or the material features of the land. Storying can be defined as a relational meaning making process that points out the interconnectedness of humans with the natural world situated across space and time. Furthermore, storying creates the metalanguage and a frame of reference to observe, dwell into, investigate, and reflect upon the natural environment and its interconnections to humans and the ecosystem as a whole (see also Renshaw & Tooth, 2017).

Phenomenon-based learning

The *Riddle of the Spirit* project and its design drew on so called phenomenon-based learning, advocated by the Finnish core curricula (FNBE, 2016, 2017). The starting point in phenomenon-based learning is an interdisciplinary real-world phenomenon. Phenomena are approached as complete entities via project and inquiry-based teaching and learning activities. Accordingly, the starting point of the holistic, phenomenon-based learning in the *Riddle of the Spirit* project was

the mysterious riddle of Ukko losing control of the climate and affecting villagers' harvests. The riddle invited the children to explore climate issues through a combination of serious, yet playful, problem-defining and solution-creating phases. The available materials did not explicitly contain content on climate change but directed the children to investigate and make sense of relevant concepts surrounding that complex phenomenon. The teachers acted as facilitators and guided the children to explore the topic of climate change from various domains and perspectives.

During the joint meaning-making process, the children, as active learners and constructive knowledge builders, made sense of information acquired from different sources and modes: personal experience and knowledge, imagining, brainstorming, collective discussions and exploration of artefacts and various multimodal texts. The project relied on the children's active participation and questioning of reality, following Orr (1990), who argued that 'real learning is participatory, experiential, and interdisciplinary, not just didactic' (pp. 50). According to Orr's (1990) view on environmental education, learning can best change the way people behave when knowledge construction is in response to the life situation of learners. This thought also corresponds with Finnish curricula, which underscore meaningful learning experiences that acknowledge learners' interests, questions and needs (FNBE, 2016) and that of Multiliteracies pedagogy (New London Group, 1996; Serafini & Gee, 2017).

Material affordances for multimodal engagement

To support the children's eco-literacy, multimodal meanings were embedded into the designed materials and children's activities to create a playful, holistic and explorative learning experience. In this context, drawing on The New London Group (1996), five different modalities— linguistic, visual, spatial, gestural and audio—were purposefully incorporated into the design of the project and its unique materials. These interconnected modes of meaning were introduced to the children in various forms, including print-based texts, pictures, symbols, material artefacts and verbal interaction.

The following table (*Table 1*) illustrates the modes of meaning utilized by the *Riddle of the Spirit* and its materials:

Linguistic meanings	Visual meanings	Gestural meanings
<ul style="list-style-type: none"> ● Meaning-making and creativity expression were encouraged via dialogues and text (writing, reading, speaking and listening) ● Written story and keywords of abstract concepts, such as ‘global warming’, were used as starting points for the children’s meaning-making transformation 	<ul style="list-style-type: none"> ● Illustrations with vivid colour were used to engage the children in imagining the story context and empathizing with the characters ● Diverse signs and visual symbols, such as the newspaper, dictionary, binoculars and magnifying glass, were used to enrich imaginative playfulness 	<ul style="list-style-type: none"> ● The activities and physical props led the children to act imaginatively in multimodal ways. For example, the role-play accessories inspired the children to explore, think from other perspectives and produce meaning via gestures.
Spatial meanings		Audio meanings
<ul style="list-style-type: none"> ● Indoor classrooms and outdoor nature constituted the learning environment ● Spatial exploration was embedded as part of the meaning-making process. The children’s observations in nature and daily practices were utilized as inspirations for solving the riddle. 		<ul style="list-style-type: none"> ● The children were encouraged to explore their surroundings through their five senses, including sound ● Sound mimicking activities were used to enrich the children’s imagination of the spirits

Table 1. The interconnected modes of meaning in the *Riddle of the Spirit* project and its materials

The five modes of meaning (linguistic, visual, gestural, spatial and audio) were closely connected to each other in the project activities; hence, they formed hybrid configurations designed to promote the children’s holistic and experiential learning experiences on eco-literacy. Language and visuals were the most used modes of communication and meaning-making, utilising print-based text (reading, writing), images (drawings, illustrations, signs), dialogues (speaking and listening) and concrete material artefacts (physical props). The text description of the riddle, the spirit characters and the illustrations enriched the children’s imagination of the spirit world, while the joint dialogues facilitated by the teachers contributed to a collective

meaning-making of abstract concepts. The physical props encouraged the children to feel, act and express themselves and interact with the natural world in multimodal ways, including through senses and gestures (gestural meanings). The project was also embedded with spatial meanings, since the natural environment was utilized as a source of meaning-making. The children were encouraged to explore the environment using all their senses.

Besides the five modes of meaning, the project materials provided symbolic meanings through metaphorical representation to enrich the children's playful and imaginative explorations and sense-making of their environment and climate. For example, the role-play accessories combined text (spirit descriptions), illustrations (spirits' physical appearances) and features of daily artefacts (binoculars, magnifying glasses and masks) to enhance the children's empathic orientation to nature as animate characters; The binoculars signified observation and exploration, the magnifying glasses heralded scientific investigation and the masks attempted to distance the children from themselves and inspire them to adopt the spirits' perspectives. With the props, the children were guided to pay attention to details in the spatial environment via the identities of detectives, investigators or scientists. Likewise, the *Spirit Tower* was a metaphor of the support provided by the natural environment in the form of resources used by humans in daily activities. The gesture of slotting the cards together was a metaphor for linking those elements. In the last activity, the forest was a metaphor for togetherness and collective expectation, which was formed by the trees containing the children's wishes and thoughts. These symbolic meanings, enhanced by the project materials, engaged the children in associating meanings across domains.

Play and Imagination

In the *Riddle of the Spirit*, multiple play types enriched the children's learning activities, addressing the seven core skills of eco-literacy - empathy, collaboration, communication, creativity, systems thinking, critical thinking and problem-solving. For example, role-playing the spirit characters engaged the children in imaginative and empathic thinking by encouraging them to take on the spirits' perspectives; decoding the mysterious spirit language and the constructive play with the spirit towers and the story cubes demanded peer collaboration and systems thinking

whilst identifying patterns and connections between the cards; and creating the riddle ending called for the children to use creativity, communication and problem-solving.

Such purposefully framed play, as proposed by two sustainability educators, Amy Cutter-Mackenzie and Susan Edwards (2013), stresses that play-based learning can be an effective pedagogy to enhance eco-literacy among children, coordinating with appropriate teacher facilitation, discussion and self-exploration about relevant knowledge. Play-based activities provided opportunities for children to connect new information with their previous experiences, supporting their imagination, meaning making and knowledge construction (Cutter-Mackenzie & Edwards, 2013). Laughter and happy faces evidenced the children's enjoyment in engaging in the project's activities that were both serious and imaginative, as well as guided and spontaneous. The activities guided the children to both reality-based imaginations and imagination-based realities, which again allowed them to design new realities in addressing issues around climate change (see also Hassett & Wood, 2017).

Conclusions

Eco-literacy is an important, abstract and serious topic. Yet, as we have argued, little is yet known how to support children's learning of eco-literacy. In particular, we have little knowledge how to guide children in approaching climate change and environmental issues in general as part of dynamic networks and connections. Hence, new pedagogical models and materials are needed in Finland and more globally. In this chapter, we have discussed how a Multiliteracies pedagogy can be harnessed to support children's holistic learning experiences in eco-literacy, as illustrated by the *Riddle of the Spirit*, which served as a novel intervention in a Finnish primary school by creating a narrative, explorative, creative, multimodal and multi-sensory space for dialogues, meaning-making and creative learning on the natural environment and climate change.

Typical to Finnish early years pedagogy is to design children's learning experiences as open-ended, playful and immersive hands-on activities utilising indoor and outdoor spaces as learning environments where children are encouraged to explore and play with little if any, adult instruction. In addition to interactions with nature, the education in Finland emphasises children's autonomy, confidence and learning from experience (Kumpulainen, 2018). In the *Riddle of the Spirit* the novelty lies in its purposeful design to balance the more typical Finnish child-centric approach with more specific pedagogical efforts aimed at systematically supporting the development of children's eco-literacy skills and knowledge on issues around climate change. Here, the playful and unique designed materials and the teachers' participation and guidance in joint activities played an important role. Among others, here, the children were introduced in playful and creative ways to climate change-relevant concepts, such as carbon footprint, global warming and pollution, and to making sense of them via joint inquiry and interpretation supported by relevant designs. The unique and novel materials developed for this project acted as important available designs in the children's transformations of the identified meanings. Here, the importance of storying, phenomenon-based learning, material affordances for multimodal engagement, and imagination and play acted as the core design principles of the learning activities.

Developing an understanding about climate change and its causes is naturally a long developmental process. The *Riddle of the Spirit* project was designed to embed ‘seeds of eco-literacy’ in the children’s playful and creative activities to progressively nurture their orientation, social practices and personal meaning-making so that children can begin to learn to identify themselves as part of socio-ecological networks and consider the Earth’s well-being in their every action. The ‘seeds of eco-literacy’ also implies the sense of wonder and the sheer delight to live in this natural world, which Orr (1992) believed as the key drives for developing eco-literacy. As the project illustrates, the children were supported to identify the interconnection between themselves, climate issues and the riddle through observation, critical reflection, joint discussion and collaborative creation, with the educational goal of supporting their learning of eco-literacy for sustainable knowledge, skills and orientation to the world.

One conclusion that we draw from the *Riddle of the Spirit* project is that a Multiliteracies pedagogy and its metalanguage holds strong educational potential for the design of environmental education for young children from the perspective of eco-literacy. In their multimodal interactions mediated by the available designs of the project (i.e. designed materials, teacher support and guidance, and peer collaboration) the children actively engaged in making meaning of the interconnection between themselves, climate issues and the riddle all of which contributed to their learning opportunities of eco-literacy including an empathetic orientation to the natural world.

Our chapter also implicitly points out how participatory co-design between educational researchers and practitioners can lead to novel material and pedagogical designs, guided by the core principles of eco-literacy and the Multiliteracies pedagogy. As our work implies, design is a natural ally of future making. In a world in rapid and profound transformation educational researchers and teachers play an important role as designers of children’s learning opportunities for eco-literacy. We hope that our chapter inspires and guides further design work in this area to address the wicked problem of educating children for sustainable futures.

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